~~[illegible]~~ where are pix??

5/9/89

E.T.: What changes were made to produce the 5/11/89 version?

The Gift of Apollo

by Carl Sagan

It's a sultry night in July. You've fallen asleep in the armchair. Abruptly, you startle awake, disoriented. The television set is on, but not the sound. You strain to understand what you are seeing. Two ghostly white figures in coveralls and helmets are softly dancing under a pitch black sky. They make strange little skipping motions, which propel them upward amid barely perceptible clouds of dust. But something is wrong. They take too long to come down. Encumbered as they are, they seem to be flying -- a little. You rub your eyes, but the strange tableau persists.

Of all the events surrounding Apollo 11's landing on the Moon on July 20, 1969, my most vivid recollection is its dreamlike quality. Yes, it was an astonishing technological achievement and a triumph for the United States. Yes, the astronauts -- Neil Armstrong, Buzz Aldrin and Mike Collins (the ~~latter~~ last ~~handholding~~ keeping solitary vigil in lunar orbit) -- displayed death-defying courage. Yes, as Armstrong said as he first alighted, this was an historic step for the human species. But if you turned off the sound with its deliberately mundane and routine

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chatter, and stared into that black-and-white television monitor, you could glimpse that we humans had once again entered the realm of myth and legend.

We knew the Moon from our earliest days. It was there when our ancestors descended from the trees into the savannahs, when we learned to walk upright, when we first devised stone tools, when we domesticated fire, when we invented agriculture and built cities and set out to ~~dominate~~ subdue the Earth. The Moon's waning and waxing symbolized death and rebirth. Its phases correspond so closely to the reproductive cycling of women that it is hard not to ~~think~~ wonder if there was once some causal connection -- as the word "menstruation" (Latin, "mensis" = "month") reminds us. Folklore and popular songs still ~~attest to~~ tell of a connection between the Moon and love. The month and the second day of the week are both named after the Moon. Especially when we lived out-of-doors, it was a major -- if oddly intangible -- presence in our lives.

The Moon was a metaphor for the unattainable: "You might as well ask for the Moon," they used to say. For most of our history we had no idea what it was. Was it a spirit? A god? A thing? It didn't look like something big far away, but more like something small nearby -- something the size of a plate, maybe, hanging in the sky a mile above our heads. Walking on the Moon would then have seemed a screwball idea; it makes much more sense to imagine somehow climbing up into the sky on

a ladder, or on the back of a giant bird, grabbing the Moon and bringing it down to Earth. But nobody ever did.

It was not until three centuries ago that the idea of the Moon as a <u>place</u>, a quarter of a million miles away, gained wide currency. We're new at figuring out what worlds are or how they work. In that brief flicker of time, we've gone from the earliest steps in understanding the Moon's nature to actually walking on its surface. We calculated how objects move in space; ~~distilled and compressed~~ liquified oxygen ~~from~~ in the air; invented big rockets, ~~radio~~ telemetry, reliable electronics, inertial guidance, and much else. Then we sailed out into the sky.

The Moon is no longer unattainable. A dozen humans, all Americans, made those skipping motions they called "moonwalks" on the crunchy, cratered, ancient gray lava -- beginning on that July day in 1969. But since 197~~3~~2 ~~[1974?]~~ no one from any nation has ventured there. The Soviet manned lunar program ended as soon as it became clear the Americans would get there first. Indeed, none of us has gone <u>anywhere</u> since the glory days of Apollo, except into low Earth orbit -- like a toddler who takes a few tentative steps outward and then, breathless, retreats to the safety of his mother's skirts.

Once upon a time, we soared into the solar system. For a few years. Then we hurried back. Why? What happened? What was Apollo really about?

The scope and audacity of John Kennedy's ~~1961 speech~~ May 25, 1961 message to a joint session of Congress on "Urgent National Needs" that announcing the Apollo program dazzled me. We ~~[date and place?]~~ speech that

would use rockets that had not yet been designed and alloys not yet conceived, navigation and docking schemes not yet devised, in order to send a man to a world not yet explored -- even in a preliminary way, even with robots -- and we would bring him back, and we would do it before the decade was over. This confident pronouncement was made before ~~the United States had sent anyone even thirty miles up~~ any American had achieved Earth orbit.

As a newly minted Ph.D., I actually thought all this had something centrally to do with science. But President Kennedy did not talk about discovering the origin of the Moon, for example, or even about bringing samples of its surface back for study. All he seemed interested in was sending someone there and bringing him back safely. Kennedy's Science Adviser, Jerome Wiesner, later told me he had a deal with the President: If ~~Kennedy~~ the President did not claim that Apollo was about science, then he, Wiesner, would support it. So if not science, ~~then~~ what? ~~accepting~~ contentions that Apollo was a way to pump American technology. They

Later, there were arguments about "spinoff," ~~which~~ boiled down to something like this: "Give us $25 billion to put people on the Moon, and we'll throw in Tang, a free cardiac pacemaker, and a stickless frying pan." But anybody could see that if we were after orange juice substitutes, or pacemakers or frying pans -- or even mainframe computers --, we could invent them directly; we didn't have to spend $25 billion and send people to the Moon in the process. So it wasn't spinoff either.

The same technology that puts an astronomical and a telescope in Earth orbit can put a "battle station" up there. Even back then, there was much talk in military circles, East and West, about space as "high ground," about the nation that "controlled" space as "controlling" the Earth.

I kept asking. The Apollo program is really about politics, I was told. This sounded more promising. Nonaligned nations would be tempted to drift towards the Soviet Union, if it was ahead in space exploration, if the U.S. did not show sufficient "national vigor." I didn't follow. Here was the United States ahead of the Soviet Union in virtually every area of technology, and Indonesia would go communist because Yuri Gagarin beat John Glenn to Earth orbit? What's so special about space technology? Suddenly I understood.

Sending people to orbit the Earth or robots to orbit the Sun requires rockets -- big, reliable, powerful rockets. Those same rockets can be used for nuclear war. The same technology that transports a ~~scientific payload~~ man to the Moon can transport a nuclear warhead halfway around the Earth. ~~What the Apollo program was mainly about was the nuclear arms race.~~ The ~~United States and the Soviet Union were itching to demonstrate, to each other and to the rest of the world, their talent for mutual annihilation.~~ But of course strategic rockets were tested on Earth. Heaving a ballistic missile with a dummy warhead in to a target zone in the middle of the Pacific Ocean doesn't buy much glory. ~~But~~ Sending people into space, though, captures the imagination of the world. You wouldn't spend the money to launch them for this reason alone, but of all the ways of demonstrating rocket potency, this one works best. ~~The Soviet leadership understood this, and the American leadership understood it. People all over the world understood it. Possibly, I was one of the last people on Earth to understand it. For the longest time, I kept thinking that somehow it all had to do with science.~~

No ¶ Ironically, the Apollo program had consequences wholly at variance with its nationalist political purpose, a point I'll return to later.

There were six more missions after Apollo 11, all but one of which successfully landed on the lunar surface. Apollo 17 was the first to carry a scientist. But as soon as he got there, they cancelled the program, Apollo had already served its purpose. The first scientist and the last human to land on the Moon were the same person.

At the time, the immense and reliable Saturn V launchers for Apollos 18, 19 and 20 had come off the assembly line and were ready to go. If we weren't headed to the Moon anymore, at least the Saturn V's could have carried giant payloads into space. All three together could have lifted [CHK] metric tons into low Earth orbit. If we didn't have elaborate scientific packages to put into Earth orbit, the Saturn V's could at least have lifted the parts for future constructions -- girders, aluminum tubing, habitation modules. If they had, we would today be engaging in few debates about constructing a space station. Most of the building blocks would be there already, and our principal task would be to bolt and weld them together. [They could have stayed there indefinitely, waiting until we were ready.] But we chose to make the remaining Saturn V's into museum pieces. And we closed down the assembly line.

Apollo was not mainly about science; it was not even mainly about space. Apollo was about politics and nuclear war and the coercion and intimidation of nations. There were those who envisioned other goals for Apollo -- science and

-- about as much as a major strategic weapons system --

exploration, for example -- and I was one of them. But that was not ~~why~~ some $25 billion ~~(upgrade to~~ (in current dollars) was spent.

N.A. Nevertheless, ~~excellent~~ good space science was done. We now know much more about the composition, age and history of the Moon, and the origin of the lunar landforms. We have made progress in understanding where the Moon came from. (The most fashionable current idea is that it was produced in the collision of a giant asteroid or comet with the Earth around 4.5 billion years ago ~~[CHK date]~~.) More important, Apollo provided an aegis, an umbrella under which exquisitely engineered robotic spacecraft were dispatched throughout the solar system, making a preliminary reconnaissance of dozens of worlds. The last of ~~those spacecraft~~ them, Voyager 2, will encounter the Neptune system this August. The offspring of Apollo are now reaching the solar system frontiers. If not for Apollo -- and, therefore, if not for the political purpose it served -- I doubt whether the historic American efforts in planetary exploration would have occurred. Something similar is true for the pioneering Soviet efforts in solar system exploration, including the first landings of robot spacecraft on another planet.

Apollo ~~engaged~~ conveyed a confidence, energy and breadth of vision that did captured the imagination of the world. That, too, was part of its purpose. It ~~conveyed~~ inspired an optimism about technology, an enthusiasm for the future. If we could go to the Moon, what else was now possible? Even those who were not admirers of the United States readily

acknowledged that -- whatever the underlying reason for the program -- the nation had, with Apollo, achieved greatness.

Since the end of Apollo, the American space program has been in decline. It has been given no long-term coherent purpose. Like all bureaucracies without real direction from above, NASA has attempted to make do -- to maintain existing programs and field centers, to go by slow steps. Predictably, budgets were cut. Morale deteriorated. Other claimants arose for the NASA budget. Other government agencies attempted to expropriate parts of NASA. Shuttle was developed, although exactly why we needed humans in low Earth orbit -- when robots are so capable, so much cheaper, and do not risk human life -- was never made clear. People whose parents witnessed humans walking on the Moon now thrilled that we were able to launch a shuttle to 200 miles altitude without mishap. An American space station was announced as "the next logical step" -- but we heard nothing about where it was a logical step to. What exactly was the space station for? Could we perform those functions without a space station? No one was saying.

The United States, after launching dozens of trailblazing interplanetary missions in the 1960's and the 1970's, had not launched a single spacecraft to the Moon or the planets in the last 11 years. This drought has now ended with the successful launch of Magellan, an orbiter for radar mapping the hidden surface of Venus. There is another long-delayed mission just coming out of the pipeline -- Galileo to Jupiter -- which (my

[not to arrive at its destination until late 1995]

fingers are crossed) is scheduled to be launched this October. Congress has before it a critical proposal to reinvigorate the unmanned planetary program, CRAF/Cassini -- two spacecraft, one of them designed and paid for jointly with the European Space Agency, to rendezvous with a comet, fly by asteroids, orbit Saturn, and send a probe into Titan, a moon covered with the building blocks of life. All this for the price of maybe ~~two B-2 bombers~~ one aircraft carrier [CHK]. Sounds like a bargain to me.

The responsibility lies fundamentally not at NASA's door, but at the President's -- several consecutive presidents.

Still, something is seriously wrong ~~with NASA~~, and it's not hard to see what it is: ~~NASA~~ The U.S. space program has lost its way. NASA lacks a compelling political purpose of the sort that Apollo provided. NASA needs a presidentially-mandated long-term goal.

I've learned my lesson. Governments do not spend these vast sums just for science, or merely to explore. They need another purpose, and it has to make real political sense. The United States and the Soviet Union have by now amply demonstrated their ability to deliver nuclear weapons over ~~They have~~ long distances with ballistic missiles. There is no longer any politically coherent purpose for competition in space. What's left? I think the answer is clear: Cooperation.

I proposed in these pages [Parade, date], a long-term program for the exploration of Mars, a program that would culminate in a manned and womanned mission to that planet spearheaded by the United States and the Soviet Union -- but including participation by Europe, Japan and other nations. I believe it would consolidate the disparate constituencies of

(now much diminished)

NASA, be technologically a ~~much~~ smaller step than Apollo was in 1961, and represent a ~~relatively~~ much smaller annual increment to the NASA budget than Apollo did. It would provide the kind of aegis and justification for a wide range of other NASA activities, including robotic exploration of Mars and other worlds, long duration human spaceflight, and construction in Earth orbit. It would provide a reason for the space station. But most of all, such an objective could serve an urgent political task: binding up the United States and the Soviet Union in a shared endeavor of historic proportions on behalf of the human species. It can be done in slow steps with adequate protection by each side against political change of heart by the other, and without dangerous technology transfer.

Since then, President Gorbachev has repeatedly invited the United States to join the USSR in just such an endeavor. The House of Representatives voted (in the 1989 NASA authorization bill) ~~to initiate this mission~~ for Mars as the long-term focus of the U.S. space program. NASA's new Office of Exploration has called for human exploration of Mars as a major NASA goal, as has the 1988 Republican Party Platform. Democratic presidential aspirants, including Sen. Albert Gore and the Rev. Jesse Jackson, have endorsed joint U.S./U.S.S.R. Mars exploration. And the Planetary Society's Mars Declaration has been signed by a strikingly ecumenical group of Americans, including leaders of peace groups and retired Army, Navy, Air Force and Marine general and flag officers; religious leaders and astronauts, including the full crew of

Apollo 11; labor and industry executives; politicians and poets; Nobel laureates, sports figures, ambassadors, university presidents and Presidential advisers; former cabinet members; and every former NASA administrator since the agency's founding but one. All human exploration of Mars needs -- as did Apollo -- is a Presidential commitment.

But why Mars? Why not return to the Moon? It's much closer and we've proved we know how to send people there. Yes, but I'm concerned that the Moon is a long detour, if not a dead end. We've been there. We've even brought some of it back. People have seen the Moon rocks, and for reasons that I believe are fundamentally sound, they are bored by the Moon. It is a static, airless, waterless, dead world. Mars by contrast has weather, dust storms, seasonal changes, its own moons, immense volcanoes, seasonally varying polar ice caps, enigmatic landforms, and ancient river valleys indicating that massive climatic change has occurred on a once Earthlike world. Mars also holds out some prospect of past or possibly even present life. None of this is true for the Moon. Nor is the Moon an especially desirable test bed or way station for Mars. The Martian and lunar environments are very different, and the Moon is as distant from Mars as the Earth is. The machinery for Martian exploration can better be tested in Earth orbit or on the Earth itself. ~~And the fact that it's harder to get to Mars is an advantage.~~

I believe that a healthy and successful NASA must broaden its constituency. For one thing, it needs to make a major

Whatever the nationalist political and military purpose of Apollo may have been, ~~Travel is broadening~~. When you pack your bags for a big trip, you never know what's in store for you.

international effort to monitor the Earth from space in order to help preserve our small world. It needs to make a much more serious effort at robotic exploration of other worlds. This is not just a matter of catering to a well-demonstrated and widespread passion for exploration and discovery; if we didn't have an ounce of adventuresome spirit in us, it would still be prudent and cost-effective to explore the planets [see box]. But most of all, NASA needs to make the connection of spaceflight with international understanding ~~and world~~ peace. Protecting the environment, forging common purpose with other nations -- especially former adversaries -- and re-exciting the imaginations of people all over the world constitutes a sufficient political payoff to justify a major, consistently funded American space program. I do not see any other activities, such as ~~vague~~ appeals to national prestige or promises of technological spinoff, that provide a political justification suitable for the 1990's. And Star Wars, SDI -- in addition to its manifold technological and fiscal problems -- would lead us to a time in which the space around the Earth is filled with thousands of "kill vehicles," space mines, laser battle stations, and interceptors; ~~it is easy to see that~~ such a future is inconsistent with free scientific inquiry, with international cooperation, and with protecting rather than attacking the Earth.

* * *

The Apollo astronauts on their way to and from the Moon photographed their home planet. It was a natural thing to do,

but it had consequences that few foresaw. For the first time, the inhabitants of Earth could see our world from above, the whole Earth, the Earth in color, the Earth as ~~a lovely~~ an exquisite white and blue world set against the vast darkness of space. Those images have awakened our slumbering planetary consciousness; they provide incontestable evidence that we all share the same ~~fragile~~ vulnerable planet -- our only home in all the solar system. They remind us of what is important and what is not. The Saudi Arabian astronaut, ~~Prince~~ Sultan bin Salman bin Abdul Aziz al-Saud, after his observations of the Earth from the Discovery 5 shuttle, in 198_ [CHK], recalled: "The first day or so, we all pointed to our countries. The third or fourth day we were pointing to our continents. By the fifth day, we were aware of only one Earth."

We may have found that perspective just in time, just as our technology threatens the habitability of our world [see box]. Whatever the reason we first mustered the Apollo program, however mired in ~~the~~ Cold War ~~it was~~ nationalism ~~origins were~~, the inescapable ~~realization~~ recognition of the unity and fragility of the Earth is its clear and luminous dividend, the unexpected gift of Apollo. ~~Ironically,~~ What began in deadly competition ~~ironically~~ has led to see ~~shown~~ us that global cooperation is, ~~in ways we had not glimpsed,~~ the essential prerequisite for our survival. Travel is broadening. It's time to hit the road again.

~~Those photographs show a lush planet brilliant in the~~ sunlight, afloat in black vacuum, the world on which we learned to walk. We can look up tonight and see that silver

world, the Moon, and know with a chill of recognition that we walked there once. And in a few months, [CHK] when the Earth catches up to it (it's now on the far side of the Sun), we will be able to recognize a steady, beckoning, unflickering point of red light in the night sky, the planet Mars -- and know that we can walk there one day. Our transition to becoming a multiplanet species could begin early in the new century. It ~~is~~ 's only a matter of deciding.

Box 1

THE LAST PICTURE SHOW

Voyager 2 will encounter Neptune on August 25, 1989. It will obtain pictures and ~~many~~ much other ~~kinds of~~ scientific data about this giant gas planet; its strange ring arcs; and its two moons (there may be more), one of which has an atmosphere (and perhaps an ocean of liquid nitrogen). This is the final ~~"stop"~~ port of call on Voyager's grand tour of the solar system. There are no more worlds on its itinerary. But before it passes the planetary frontiers, it is scheduled [CHK] to take one last picture -- over its shoulder, of the inner solar system . The planets will appear as a few points of light. One of them, a tiny blue dot set against the spangle of the Milky Way, will be the Earth. From the distance of Neptune, it will seem no more than a faint star. This picture could have an influence on how we view ourselves ~~even more~~ as powerful ~~than~~ as the Apollo images of our planetary home.

Box 2

Mars Declaration

[to come]

If you agree with The Mars Declaration, cut out this copy, sign it, and send it to Parade, [address]. We'll present ~~send~~ it ~~on~~ to President Bush.

Box 3

PHOBOS

Photograph of Phobos, the innermost moon of Mars, taken by the Soviet spacecraft Phobos 2 shortly before the vehicle lost lock on Earth and tumbled out of control. Much information was obtained, but the mission terminated before its ~~main~~ highlight -- the landing of two sub-spacecraft ~~were to land~~ on Phobos. ~~This Martian moon seems~~ a world rich in organic matter and ~~is~~ a likely base for the future human exploration of Mars. The Soviets have recently announced their continuing commitment to an ambitious program of Martian exploration by robotic spacecraft -- including a 1994 dual mission with landers, penetrators and exploratory balloons, and a rover/return sample mission toward the end of the decade.

Box 4

WHY EXPLORE THE PLANETS?

THE EARTHBOUND, PRACTICAL REASON

"For the first time in my life I saw the horizon as a curved line. It was accentuated by a thin seam of dark blue light -- our atmosphere. Obviously this was not the 'ocean' of air I had been told it was so many times in my life. I was terrified by its fragile appearance."

-- Ulf Merbold, West German astronaut aboard [name of shuttle]

There are three unexpected, potentially disastrous threats to ~~the Earth's~~ our planet's atmosphere and therefore to the global environment. ~~All have been widely discussed:~~ They ~~Each of them~~ can be avoided only by deep and long-term cooperation of the nations of the Earth. [Parade "Common Enemy," date]:

(1) The assault on the protective ozone layer by CFC's used in refrigerators, air conditioners, aerosol spray cans, and insulating containers for fast foods; it threatens greatly increased skin cancer and the destruction of microorganisms at the base of the great food chain on which our lives depend (Parade, date).

(2) The increasing greenhouse effect caused by CFC's and the burning of coal, oil, natural gas and gasoline; it threatens catastrophic global warming, destruction of farmland, and coastal flooding all over the planet (Parade, date).

(3) Nuclear winter, through the explosion of even a small fraction of the nearly 60,000 nuclear weapons in the world; it threatens precipitous cold and dark, agricultural collapse and the possible death by starvation of billions of people all over the Earth (Parade, date).

Studying the planets has played a major role in the discovery and assessment of each of these doleful prospects. Fundamental contributions were made by scientists who had cut their teeth in investigating other worlds. Some of the earliest calculations of ozone depletion relied on studies of the upper atmosphere of Venus, ~~and~~ The antiseptic surface layer of Mars is believed due to the near absence of ozone in its atmosphere. The clearest demonstration that a greenhouse effect can work a planetary catastrophe is Venus with its 900°F surface temperature. And the first step towards discovery of nuclear winter came from the study of Martian dust storms. What new insights about how to avoid these catastrophes will come from planetary exploration? What new catastrophes, brought about by our technological prowess, will planetary exploration help uncover?

There is a case for sending spacecraft to other worlds for reasons of the most practical and urgent utility here on Earth. Even if we were focussed exclusively on our Earthbound problems, planetary exploration would be a superb and essential investment.